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The Effectiveness of Pelvic Floor Muscle Rehabilitation in Female Athletes with Urinary Incontinence: A Systematic Review

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ABSTRACT

Background: High-level sports activities in female athletes carry a significant risk of triggering urinary incontinence due to the sudden increase in abdominal pressure during movement. **Objective**: The objective of this systematic review is to assess the effectiveness of pelvic floor muscle training in nulliparous female athletes for the prevention and treatment of urinary incontinence. **Method**: Following the PRISMA guidelines, this systematic review of randomized controlled trials was conducted using two main search engines – PubMed and Science Direct, and included scientific articles published over the last fifteen years. This review focused on the PICO framework to identify studies eligible for inclusion. Nulliparous female athletes, aged over or equal to 18 years, with a body mass index ranging between 18 and 30 kg/m^2, and who were suffering from urinary incontinence, were included. The intervention consisted of pelvic floor muscle training, and the comparison groups consisted of athletes with or without additional interventions. The outcomes focused on the prevention and treatment of urinary incontinence, including symptom reduction, improvement in pelvic floor function, and increase in overall continence. Only randomized controlled trials, published in either French or English were included. **Results**: One-hundred and twenty-seven articles were identified, reviewed, and checked according to the inclusion criteria, and only eight articles were eligible for inclusion. The studies were analysed and evaluated using the Cochrane Risk of Bias Tool (RoB 2). The results showed that pelvic floor muscle training in female athletes reduces urinary incontinence regardless of the technique used. Additionally, pelvic floor muscle training, which includes pelvic floor awareness, strengthening, and increasing contraction power, and pre-activation of pelvic floor contraction during sports activities, can help prevent pelvic dysfunctions, particularly urinary incontinence. **Conclusion**: In conclusion, this systematic review highlights the importance of integrating pelvic floor muscle training into physical preparation programs of female athletes to prevent and manage urinary incontinence. Early intervention and structured training protocols can help mitigate any pelvic dysfunctions in female athletes and improve their performance and quality of life.

KEYWORDS: Athletes, Exercise Training, Female, Pelvic Floor, Urinary Incontinence.

Introduction

According to the International Continence Society (ICS), urinary incontinence (UI) is defined as "the complaint of any involuntary leakage of urine" [1] and it includes different types, including but not limited to stress urinary incontinence (SUI), which usually occurs during physical exertion like sports, coughing, and sneezing [2], urge urinary incontinence (UUI), which is associated with a sudden and intense need to urinate [3]. Generally, women may experience a combination of these symptoms, which is known as mixed urinary incontinence (MUI) [4].
The mechanism of continence involves coordination between muscles within and around the pelvic cavity, specifically pelvic floor muscles, which provide support and maintain urethral closure. Under normal conditions, rapid closure of the urinary orifices is ensured through the

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fast-contracting phasic fibres of the pelvic floor muscles, ensuring continence during transient increases in intra-abdominal pressure [5]. Hence, weakness or dysfunction of these muscles, especially in cases of stress urinary incontinence, can compromise this mechanism and lead to involuntary leakage [6].

In female athletes, especially those participating in high-impact or repetitive-load sports, several risk factors including repetitive landings, impaired core-pelvic coordination, hormonal fluctuations, low energy availability, and a history of eating disorders may contribute to pelvic floor weakness and fatigue, ultimately leading to dysfunction [7, 8]. Consequently, pelvic floor muscle training (PFMT) is recommended as a first-line intervention to improve strength and endurance [9]. For instance, the National Institute for Health and Care Excellence (NICE) recommends a supervised PFMT program for three months as the first-line treatment for UI in the general population [10].

Sports, involving jumping and running appear to carry a higher risk of triggering urine leakage due to the sudden increase in intra-abdominal pressure [11, 12], further causing direct stress and fatigue of the pelvic floor muscles, consequently reducing blood flow and oxygen supply [13]. That is why elite female athletes are considered a high-risk group for all types of urinary incontinence, with reported prevalence of UI ranging between 23% and 41% [4, 11]. For instance, studies have shown that stress incontinence in nulliparous athlete females is associated with the type of sport performed. In a previous systematic review, Mattos Lourenco (2018) reported that the prevalence of urinary incontinence ranged from 5.56% among those performing low-impact activities to 80% among those engaging in high-impact activities such as trampoline exercises [14]. This risk may be attributed to an imbalance of forces between the abdomen and pelvis, which could lead to early alterations in the physiological vesicoureteral angle and result in mixed urinary incontinence, predominantly stress urinary incontinence [15]. Furthermore, several risk factors were shown to be associated with urinary incontinence in female athletes, notably high body mass index (BMI), having eating disorders, and reduced foot flexibility [16, 17].

In such cases, physiotherapy has been shown to offer potential benefits in the management and treatment of female athletes suffering from UI [18]. In this regard, the objective of this systematic review is to analyse and synthetise randomised controlled trials investigating the effectiveness of pelvic floor muscle training in preventing and treating UI among nulliparous female athletes.

Methods

This systematic review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.

Eligibility Criteria

For this systematic review, a PICO framework was followed to identify the studies addressing the objective of this study, the Population (P) consisted of nulliparous female athletes that are known to have urinary incontinence, aged 18 years and older, with a body mass index between 18 and 30 kg/m^2. The Intervention (I) was pelvic floor muscle training, and the Comparison (C) group consisted of female athletes who did not participate in any intervention, and this to evaluate the effectiveness of pelvic floor muscle training on managing and preventing urinary incontinence in these women. Further, the Outcome (O) focused on the prevention as well as the treatment of urinary incontinence, including the reduction in symptoms, improvement in pelvic floor functions, and increase in overall continence.

As per the exclusion criteria, this systematic review did not consider articles published more than fifteen years ago, literature reviews, case reports, cross-sectional studies, prospective cohorts or case series. Moreover, we also excluded studies which included postpartum women and studies focusing on other types of pelvic dysfunction, such as prolapse, infections or sexual dysfunction.

Information Sources

The literature search was done between June 2024 and December 2024, on two search engines, PubMed and Science Direct, where articles in both French and English languages were reviewed. Date restriction was applied and only those published less than 15 years prior were screened. The search was performed manually by the author and her direct supervisor, following the PRISMA guidelines.

Search Strategy

The search strategy was performed using different keywords in both English and French languages, notably "urinary incontinence", "incontinence urinaire", "Female Athletes", "Sports women", "Sporty women", "femme sportive", "femme sportive de haut niveau", "high performance female athlete", "Pelvic Floor muscle training", "entrainement du plancher pelvien". For the database search, MeSH terms were used noting "OR" and "AND" to cover all potential studies related to the topic and to ensure maximum retrieval of relevant studies. Only studies focusing on humans were included in this systematic review.

The generic search equation used was the following: ("urinary incontinence"[MeSH Terms] OR "urinary incontinence" OR "incontinence urinaire") AND ("female athletes" OR "sportswomen" OR "sporty women" OR "femme sportive" OR "femme sportive de haut niveau" OR "high-performance female athlete") AND ("pelvic floor muscle training"[MeSH Terms] OR "pelvic floor training" OR "pelvic floor rehabilitation" OR "entrainement du plancher pelvien").

Selection Process

The selection of studies was conducted in two stages. First, all identified titles and abstracts from PubMed and ScienceDirect were screened based on relevance to the topic. Duplicates and irrelevant records were removed. In the second stage, full-text articles were reviewed to assess eligibility according to the predefined inclusion and exclusion criteria.

Data Collection Process

For the process of data collection, the researcher and her supervisor independently reviewed the studies based on the fixed criteria. For each study included specific information was collection, including the authors' names, year of publication, country, population characteristics, intervention details, comparator group details, outcomes measured and key findings. When facing disagreements, researchers discussed and reached a consensus.

Data Items

Data items were pre-defined and systematically extracted from the RCTs eligible to be included in this systematic review. This included:

- Study characteristics: First author, year of publication, and country of the study.
- Population details: number of participants, age range or mean age, parity status, athletic status (type of sport), and BMI.
- Type of urinary incontinence: stress urinary incontinence (SUI), urge urinary incontinence (UUI), and mixed urinary incontinence (MUI)
- Intervention: Description of the PFMT protocol used, including duration, frequency, type, supervision, and other additional elements if available.
- Comparison: Description of the control group conditions (no intervention, education or unsupervised protocols)

- Outcomes: Primary and secondary outcomes used including frequency, quantity and severity of urinary incontinence, pelvic floor muscle strength, quality of life, and contraction technique.
- Findings: between-group differences, statistical significance, and effect (improvement or no change).

Study Risk of Bias Assessment

To assess the risk of bias across the included randomized controlled trials (RCTs), we applied the Cochrane Risk of Bias 2.0 (RoB 2.0) tool, which is the Cochrane Collaboration's recommended instrument for evaluating methodological quality of randomized trials [19]. This tool was selected due to its structured approach and demonstrated validity in systematically identifying potential sources of bias that may affect study outcomes. The RoB 2 tool evaluates five different domains including bias arising from the randomisation process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in measurement of the outcomes, and bias in selection of the reported results [19]. Each domain is rated as having low risk, some concerns, or high risk of bias. The overall risk of bias for each study is then determined based on these domain-level judgments. Two independent reviewers (the researcher and supervisor) assessed the studies, and discrepancies were resolved through discussion.

This tool has been validated in multiple systematic review settings and is known for its rigorous criteria and reproducibility [20, 21]. Its structured signalling questions and decision algorithms ensure consistency across assessments and reduce subjectivity. The application of RoB 2.0 improves transparency in the appraisal of the internal validity of randomized trials.

Effect Measure

In this systematic review, the primary effect measures considered were those reported directly by the included randomized controlled trials. These included: Percentage change in frequency or quantity of urinary incontinence episodes, changes in pelvic floor muscle strength, measured through validated scales such as the Oxford scale or EMG biofeedback, improvement in quality of life based on self-reported measures, reduction in urine loss often measured using the Pad test, and changes in correct contraction technique, where applicable. As this review did not include a meta-analysis, the effect measures were not pooled statistically.

Synthesis Methods

Given the heterogeneity of the intervention protocols in the selected and included RCTs, findings were synthesised narratively and compared qualitatively across studies, taking into account variations in intervention protocols, outcome definitions, and measurement tools. A structured table was developed to extract and compare objectives, interventions, populations, comparators, outcomes, and conclusions. This allowed for the identification of common patterns, contrasting results, and intervention-specific effects across studies.

Results

Study Selection

The study selection was based on the PRISMA flow diagram (Figure 1). The research process was performed on PubMed and Science Direct, based on pre-defined keywords. At first, a total of 127 studies were reviewed. Twenty-one studies were then excluded due to duplication between the two databases. The initial screening yielded 106 studies, of which 77 were removed for being irrelevant to our research topic. Among the remaining 29 studies, the eligibility assessment led to the exclusion of 19 studies for various reasons. The reasons taken into consideration were the recruitment of male participants, studies being systematic reviews, studies assessing outcomes other than the ones mentioned in the PICO framework of our work, studies that included a combination of different

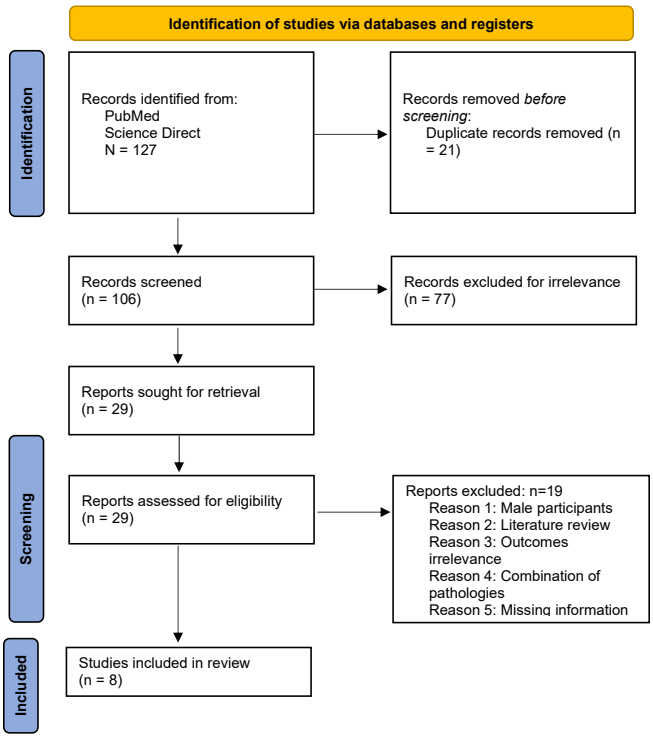

Figure 1 PRISMA Flowchart.

pathologies, and studies with missing information. Following this process, a total of 8 studies were finally included in this systematic review.

Risk of Bias Assessment

The risk of bias assessment using the RoB2 tool (Table 1) showed that most studies had some concerns in several domains, with only a few rated as high-risk. Studies such as Ferreira et al. (2014), Szumilewicz et al. (2019), Koenig et al. (2021), and Piernicka et al. (2022) mostly had some concerns with certain domains rated as low risk, resulting in an overall judgment of "some concerns" [22, 23, 24, 25]. On the other hand, studies such as Pires et al. (2020), Piernicka et al. (2021), Da Roza et al. (2012), and Sousa et al. (2015) had multiple domains rated as high risk, which led to an overall high risk of bias judgment [25, 26, 27, 28, 29]. Yet, all these studies were included in this systematic review due to their relevance in addressing the objective of this study.

Participant and Study Characteristics: Demographics and urinary incontinence profiles

As previously mentioned, a total of eight studies were included in this systematic review (Table 2). Studies were mainly published between 2012 and 2022, with four studies conducted in Portugal [22, 26, 28, 29], three in Poland [23, 25, 27], and one in Switzerland [24]. The sample size of the studies ranged between a minimum of nine participants [29] to a maximum of 84 participants [23].

Additionally, seven out of eight studies included two groups: one experimental and one control group. Only one study [23] divided the participants into three groups: a usual advice group, a biofeedback group and a control group. Furthermore, all participants were nulliparous women involved in different athletic activities, such as volleyball, running, or multiple athletic disciplines. The reported mean ages of participants ranged from 19.1 ± 2.11 years to 23 ± 3 years, with one study [30] including a broader age range of 18 to 70 years. Regarding BMI, all studies included participants with BMI between 18 and 30 kg/m^2. The reported mean BMI values across studies ranged from 20.8 ± 1.1 kg/m^2 to 22.8 ±

Table 1 Risk of Bias Assessment

Authors and Year of Publication	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Overall Risk of Bias Judgment
Ferreira et al. (2014)	Some concerns	Some concerns	Low risk	Some concerns	Some concerns	Some concerns
Pires et al. (2020)	Some concerns	High Risk	Low risk	Some concerns	Some concerns	High Risk of bias
Szumilewicz et al. (2019)	Low risk	Some concerns	Low risk	Some concerns	Some concerns	Some concerns
Koenig et al. (2021)	Low risk	Some concerns	Low risk	Some concerns	Some concerns	Some concerns
Piernicka et al. (2022)	Some concerns	Some concerns	Low risk	Some concerns	Some concerns	Some concerns
Piernicka et al. (2021)	Some concerns	Some concerns	High Risk	High Risk	Some concerns	High Risk of bias
Da Roza et al. (2012)	Some concerns	Some concerns	Low risk	Some concerns	High Risk	High Risk of bias
Sousa et al. (2015)	High Risk	Some concerns	High Risk	Some concerns	Some concerns	High Risk of bias

Domain 1: Selection Bias – Random sequence generation and allocation concealment

Domain 2: Performance Bias — Blinding of participants and personnel, deviations from intended interventions.

Domain 3: Attrition Bias – Incomplete outcome data and participant dropout rates.

Domain 4: Detection Bias – Blinding of outcome assessors and reliability of measurement methods.

Domain 5: Reporting Bias – Selective reporting and consistency with pre-specified outcomes.

Note: Risk levels were rates as Low risk, Some concerns, and High Risk based on criteria outlined in Cochrane Handbook for Systematic Reviews of Interventions (RoB2). The Overall risk of bias judgment reflects the highest level of concern identified among all five domains.

Table 2 Characteristics of Included Studies: Population Demographics and Urinary Incontinence Profiles

		Population Details						Characteristics of urinary Incontinence	
Authors (Year)	Country	Sample size	Group Division	Age range (years)	Parity Status	Athletic Status	BMI (Kg/m^2)	Type of Urinary Incontinence	Duration of UI (years)
Ferreira et al. 2014)	Portugal	32	EG: 16 CG: 16	EG: 19.4 ± 3.24 CG: 19.1 ± 2.11	P0	Volleyball Athletes	EG: 22.8 ± 2.57 CG: 21.5 ± 1.81	SUI	EG: 2.4 ± 1.67 CG: 1.6 ± 0.72
Pires et al. (2020)	Portugal	14	EG: 7 CG: 7	EG: 22.71 ± 4.99 CG: 21.83 ± 5.19	P0	Volleyball Athletes	EG: 21.37 ± 2.14 CG: 21.75 ± 0.97	SUI	NS
Szumilewicz et al. (2019)	Poland	84	usual advice: 26 Biofeedback: 31 CG: 27	23 ± 3	P0	Future exercise professionals	22 ± 3	MUI	NS
Koenig et al. (2021)	Switzerland	77	EG: 38 CG: 39	18 - 70	P0	Runners	18 - 30	SUI or MUI	>1
Piernicka et al.(2022)	Poland	51	EG: 25 CG: 26	22 ± 2	P0	Multiple sports	EG: 21.15 ± 1.47 CG: 21.91 ± 3.52	MUI	NS
Piernicka et al. (2021)	Poland	32	EG: 13 CG: 19	23 ± 3	P0	Multiple sports	EG: 21.06 ± 1.65 CG: 22.15 ± 3.67	MUI	NS
Da Roza et al. (2012)	Portugal	16	EG: 7 CG: 9	20 ± 0.8	P0	Multiple sports	20.8 ± 1.1	Any type of UI	NS
Sousa et al. (2015)	Portugal	9	EG: 4 CG: 5	21.78 ± 3.6	P0	Multiple sports	22.4 ± 2.4	Any type of UI	NS

2.57 kg/m^2.

Concerning the urinary incontinence characteristics, two studies specifically focused on participants with stress urinary incontinence [22, 26], while three studies included participants with mixed urinary incontinence [23, 25, 27]. Two studies [28, 29] included participants with any type of urinary incontinence, without specifying a subtype. One study [30] included participants with both stress and mixed urinary incontinence. The duration of urinary incontinence was only reported in two of the eight studies [22, 30]. Ferreira et al. (2014) reported a mean duration of 2.4 ± 1.67 years in the experimental group and 1.6 ± 0.72 years in the control group [22]. Koenig et al. (2021) specified that participants had experienced symptoms for at least 12 months [24]. The remaining six studies did not report a specific duration of urinary incontinence.

Interventions, Comparators, Outcomes and Key Findings

The interventions implemented across the included studies were all based on PFMT but varied considerably in their structure, delivery and duration (Table 3). Most studies employed multi-phase PFMT protocols that progressed from pelvic floor awareness and muscle strengthening to

functional integration of contractions during physical activity. In several studies, the PFMT protocol was accompanied by educational content, biofeedback sessions, or supervision by a physiotherapist. For example, Ferreira et al. (2014) and Pires et al. (2020) both included an initial awareness phase followed by strength and power training [22, 26], while Sousa et al. (2015) structured their protocol into four progressive stages over eight weeks [26]. Other studies, such as Da Roza et al. (2012), incorporated contraction attempts during real-life movements, including walking and running [28].

The control or comparator conditions varied across studies. Some studies, including Pires et al. (2020) [26], Piernicka et al. (2021, 2022) [25, 27], and Da Roza et al. (2012) [28], did not implement any intervention in the control groups during the study period. Others, like Ferreira et al. (2014), offered only educational sessions without structured PFMT [27]. Sousa et al. (2015) compared supervised and unsupervised application of the same PFMT protocol [29], while Koenig et al. (2021) and Szumilewicz et al. (2019) included physical activities such as short-burst running and jumping as comparators to assess reflexive pelvic floor muscle engagement in the absence of specific training [23, 24].

Outcomes were assessed using both objective and subjective tools. Objective measures included the pad test to quantify urinary leakage [22, 26, 26], vaginal manometry to assess maximum voluntary contraction (MVC) [24, 25, 28], electromyography (EMG) [24, 27], and perineometry [29]. Subjective outcomes included validated questionnaires such as the King's Health Questionnaire (KHQ) [26], the International Consultation on Incontinence Questionnaire - Short Form (ICIQ UI SF) [24, 28], the CONTILIFE score [29], and the Incontinence Impact Questionnaire (IIQ) [27].

In terms of effectiveness, the findings consistently favoured PFMT interventions. Ferreira et al. (2014) reported a substantial reduction in the volume and frequency of urinary leakage in the intervention group compared to the control group, with statistically significant between-group differences [22]. Pires et al. (2020) also reported significant improvements in leakage reduction and pelvic floor function in the intervention group, although differences in quality-of-life scores between groups were not statistically significant [26]. Szumilewicz et al. (2019) observed a higher percentage of participants achieving correct pelvic floor contraction following verbal guidance and biofeedback, with no adverse effects reported [23]. Similarly, Piernicka et al. (2022) found that participants who received biofeedback sessions followed by aerobic training demonstrated improved timing and technique in their pelvic floor contractions [25]. Although Piernicka et al. (2021) did not observe statistically significant changes in neuromuscular activity or quality-of-life scores, they observed that participants in the intervention group reported better voluntary control and more effective pelvic floor relaxation skills [27]. Da Roza et al. (2012) demonstrated significant improvements in vaginal resting pressure, MVC, and symptom severity scores [28]. Sousa et al. (2015) reported superior outcomes in the supervised group compared to the unsupervised group, including enhanced pelvic floor strength, greater improvements in self-efficacy and quality of life, and a reduction in urinary leakage [29]. Only Koenig et al. (2021) failed to show significant between-group differences in EMG activity, despite implementing a structured physiotherapy and reflex-training program [24]. Nonetheless, this study demonstrated improvements in specific timing parameters of pelvic floor contraction during running, suggesting potential neuromuscular adaptations.

Discussion

Controlling for Confounding Factors

In the present study, the work focused on three main factors. First, the prevalence rate of urinary incontinence increases with age, especially among women aged 70 years and older; where more than 40% of the female population is affected. Prevalence rates are even higher among elderly individuals and those in nursing homes [31]. By limiting our study to young women, we eliminated age as a confounding factor. Second, obesity is also recognized as a risk factor for stress urinary incontinence because excess weight elevates intra-abdominal pressure, weakening pelvic floor innervation and musculature [32]. Restricting BMI to 18 – 30 kg/m^2, helped control for this variable. Third, pregnancy and childbirth are two well-known risk factors for postpartum urinary incontinence, accounting for about 70% of cases [33]. By selecting nulliparous participants, pregnancy-related factors were excluded.

Contrasting Hypotheses on Pelvic Floor Function in Athletes

Hence, in the literature, there are two hypotheses regarding pelvic floor strength in athletic women: One confirms that athletic women should normally have strong pelvic floor muscles, given that intense exercise increases abdominal pressure and causes simultaneous contraction of the pelvic floor muscles, acting as a training stimulus [34]. Other validates the idea that intense activity can overload, stretch, and weaken the pelvic floor due to chronic and repeated increases in abdominal pressure [35]. The balance between these mechanisms likely depends on the type of sport, the training intensity, and muscle adaptability.

Impact of Pelvic Floor Muscle Training on Urinary Incontinence

The results obtained from the studies of Da Rosa et al. (2012) and Sousa et al. (2015) highlight the importance of pelvic floor muscle training, especially among women suffering from urinary incontinence and this is to ameliorate the vaginal pressure at rest, the contraction of pelvic muscles and thus decrease urine leakage [28, 29]. Moreover, these studies were especially important as they highlighted the key role of physiotherapists in providing useful information to enhance knowledge and understanding of exercise application, as well as in improving the perception of pelvic anatomy and the reassessment of pelvic floor muscle training exercises. Such presence constitutes a motivating factor that can facilitate recovery.

Synergistic Role of Strength and Biomechanics

Therefore, it can be concluded that strength is an important factor contributing to proper pelvic floor function, yet it is not the only one. Understanding the pelvic floor and the biomechanics of the synergy between the pelvic floor and the abdominal muscles is key to avoiding any type of dysfunction [36].

Overall Effectiveness of Pelvic Floor Muscle Training

Furthermore, the results of the different RCTs included in this systematic review showed that pelvic floor muscle training reduces urinary incontinence, regardless of the techniques used. This result was associated with increased body awareness of the pelvic floor, improved contraction quality through greater contraction power and reduced vaginal pressure at rest, increased maximum voluntary pelvic contraction, and finally, improved ability to integrate pelvic floor contraction during physical activity [22, 24, 26, 28, 29]. Such anticipatory activation appears essential in preventing leaks during high-impact activity [23, 25, 27].

Comparison of Techniques and Intervention Duration

However, when comparing different treatment techniques, verbal counseling was shown to produce better results than biofeedback for pelvic floor muscle training. Biofeedback has been shown to be effective in increasing awareness of correct pelvic contraction [23, 25]. Finally, the duration of the interventions in the selected studies ranged between 6 and 16 weeks, which is consistent with the results of the study by Piernicka et al., who strongly argue that the success of a pelvic floor muscle training program requires a minimum duration of at least 6 weeks [37].

Table 3 Summary of Interventions, Comparators, Outcomes, and Key Findings of Included Randomized Controlled Trials

Authors and Year of Publication	Intervention	Comparator	Outcomes Measured	Findings
Ferreira et al. (2014)	Supervised PFMT for 3 months + Education	Education Only	Pad Test + Leakage frequency	Significant decrease in leakage (−45.5%) and frequency (−14.3%) in EG vs CG ($p < 0.05$).
Pires et al. (2020)	PFMT for 4 months + awareness + muscle strengthening + Power phase	No interventions	Pad Test + KHQ + MVC /	Urinary leakage decreased in the experimental group from 2.71 ± 2.14 to 1.29 ± 1.70 ($p = 0.025$), whereas the control group showed no change (1.83 ± 2.40 to 2.00 ± 1.67 ($p = 0.741$)).
				The time × group interaction was significant ($p = 0.039$), confirming group differences over time.
				KHQ global score improved from 6.35 ± 5.19 (EG) to lower impairment vs 8.80 ± 4.62 (CG), particularly in domains of personal limitations, daily life, and emotions/social relationships.
				Symptom severity scale: 6.93 ± 5.16 (EG) vs 6.06 ± 3.32 (CG) — no significant difference (NS).
Szumilewicz et al. (2019)	PFMT + Biofeedback for 6 weeks	Verbal guidance only	EMG + Contraction Technique	Correct PFM technique: 69% EG vs 33% CG ($p < 0.05$). No adverse effects.
Koenig et al. (2021)	PFMT + Education + Power Strength + Hypertrophy Training	Reflex-based Training	EMG + Voluntary PFM contraction	No significant differences in EMG or contraction timing ($p > 0.05$).
Piernicka et al. (2022)	Biofeedback + High-Low-impact Aerobics for 6 weeks	No Intervention	IIQ + Voluntary PFM contraction	Earlier PFM activation and improved contraction technique ($p < 0.05$).
Piernicka et al. (2021)	High-Impact Aerobics + Biofeedback for 6 weeks	No Intervention	EMG + IIQ (QOL)	Improved contraction/relaxation skills, but not significant for EMG ($p > 0.05$).
Da Roza et al. (2012)	4 Stage PFMT for 8 weeks + awareness + Activity integration	No Intervention	IPAQ-SF + MVC + Manometry for voluntary PFM contraction	Vaginal resting pressure increased by 17.4 ± 6.7 cmH_2O ($p = 0.04$) and maximum voluntary contraction (MVC) improved by 16.4 ± 5.8 cmH_2O ($p = 0.04$).
				ICIQ-UI SF scores, as well as urine leakage frequency and amount, all showed statistically significant improvements ($p < 0.05$).
Sousa et al. (2015)	Supervised PFMT for 8 weeks	Unsupervised Home PFMT	Pad Test + CONTILIFE Score + Oxford grading scale	Supervised group improved PFM strength and QOL ($p < 0.05$). Unsupervised group showed no significant change ($p > 0.05$)

PFMT: Pelvic Floor Muscle Training; EG: Experimental Group; CG: Control Group; KHQ: King's Health Questionnaire; MVC: Maximum Voluntary Contraction; EMG: Electromyography; PFM: Pelvic Floor Muscle; IIQ: Incontinence Impact Questionnaire; QOL: Quality of Life; IPAQ-SF: International Physical Activity Questionnaire –Short Form; ICIQ-UI SF: International Consultation on Incontinence Questionnaire – Urinary Incontinence Short Form; CONTILIFE: Continence Life Impact Score; NS: Not significant; p< 0.05: Statistically Significant

Limitation

The limitations of this systematic review can be resumed in the absence of a well-defined training program to treat and prevent pelvic dysfunction in nulliparous female athletes. Additionally, a meta-analysis could not be performed due to significant heterogeneity among the included studies in terms of study design, intervention protocols, outcome measures, and participant characteristics.

Conclusion

Throughout this systematic review, it was shown that pelvic floor training is an essential component in preventing and managing urinary incontinence in female athlete women. Beyond reaffirming existing evidence,

this study underscores that a structured and supervised PFMT program can significantly enhance pelvic awareness, contraction control, and neuromuscular coordination – all factors that are often neglected in athletic conditioning.

From a practical perspective, the findings of this systematic review help us suggest that pelvic floor training should be systematically integrated into the physical preparation and conditioning programs of female athletes, particularly those involved in high-impact sports. Coaches, physiotherapists, and sports medicine specialists should all work in collaboration to include targeted pelvic floor exercises to improve core stability, prevent perineal dysfunction and sustain athletic performance.

From a clinical perspective, this systematic review provided evidence to guide the development of standardized sport-specific PFMT protocols that can be adapted based on athletic discipline and training intensity. Therefore, future studies on the rehabilitation program and the choice of techniques are needed to develop more robust protocols and achieve a maximum treatment effectiveness as well as long-term prevention of urinary incontinence in female athletes.

Abbreviations

BMI:	Body Mass Index
CG:	Control Group
EG:	Experimental Group
EMG:	Electromyography
ICS:	International Continence Society
MUI:	Mixed Urinary Incontinence
MVC:	Maximum Voluntary Contraction
NICE:	National Institute for Health and Care Excellence
PFMT:	Pelvic Floor Muscle Training
PRISMA:	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RoB 2:	Cochrane Risk of Bias Tool
SUI:	Stress Urinary Incontinence
UI:	Urinary Incontinence
UUI:	Urge Urinary Incontinence

Statement and declaration

Authors' contribution

The author confirms her contribution in all the steps of this study, including research, review, writing, documentations, or else.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Competing Interests

Not Applicable.

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Not Applicable.

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